MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2017/2018

ETM2046 – ANALOG AND DIGITAL COMMUNICATIONS

(RE)

17 MARCH 2018
9.00 a.m – 11.00 a.m
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 7 pages excluding cover page with 4 questions only.

2. Attempt ALL 4 questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the answer booklet provided

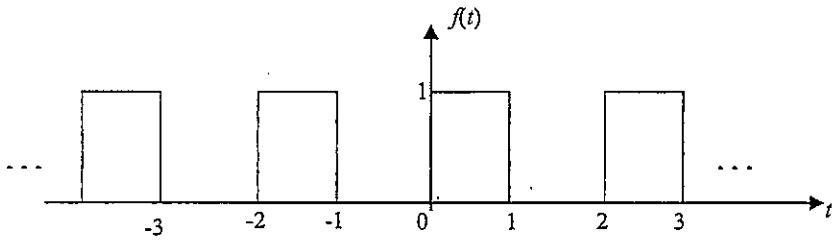
QUESTION 1

a) Explain the advantages of digital communication over analog communication

[3 marks]

b) Obtain the trigonometric Fourier series for the waveform below

[12 marks]



c) Given $x(t) = rect\left(\frac{t}{4}\right)$, find the Fourier Transform of:

i) $3x(t) + x(2t)$

ii) $x(t)\exp(j6\pi t)$

iii) $\frac{d^2x(t)}{dt^2}$

[4+3+3 marks]

Continued .....

QUESTION 2

(a) Using a block diagram and mathematical derivation, show how the Full AM signal (DSB-LC) is produced.

[7 marks]

(b) Sketch the frequency spectrum of the Full AM signal (DSB-LC) derived in part (a).

[3 marks]

(c) With the aid of block diagram, show the design of an Armstrong indirect FM modulator to generate an FM carrier with a carrier frequency of 98.8 MHz and Δf=50kHz. A narrowband FM generator is available at a carrier frequency of 125 kHz and a frequency deviation Δf=10Hz. You are given an oscillator with an adjustable frequency in the range of 10 to 11MHz, plenty of frequency doublers (x2) triplers (x3) and quintuplers (x5).

[15 marks]

Continued .....

QUESTION 3

(a) State three advantages and two disadvantages of Pulse Code Modulation (PCM) technique to convert analog signals into digital form.

[5 marks]

(b) Given an audio system with sampling frequency, f_s of 44.1 kHz and 16 bits quantization, determine the following:

(i) The maximum audio frequency, f_M

[2 marks]

(ii) Number of discrete levels it can produce

[2 marks]

(i) The bit rate, R_b

[2 marks]

(ii) Is it possible to stream this audio over 512 kbps bandwidth internet? Explain

[2 marks]

(c) Sketch the corresponding signalling line code waveforms of the PCM binary data of 1101001 using Manchester.

[2 marks]

(d) A 9,600 bits/s data terminal is connected to a modem. What is the transmission bandwidth, B_T required at the modem output for each of the following schemes? 50% roll-off shaping is used in all cases.

(i) Binary ASK.

[3 marks]

(ii) Binary FSK. Assuming that the frequency deviates ±3,600 Hz about the carrier.

[4 marks]

(iii) 16-state QAM.

[3 marks]

Continued .....

QUESTION 4

(a) Explain the word 'entropy' for a message source.

[2 marks]

(b) Briefly describe and state the advantage of the Forward Error Control (FEC).

[4 marks]

(c) Given the probabilities of the 4 symbols [A, B, C, D] of a source are:

$$P(A) = 0.5, \quad P(B) = 0.3, \quad P(C) = 0.15, \quad P(D) = 0.05$$

Determine the following:

(i) Information content for each of the symbols

[4 marks]

(ii) Entropy of the source, H

[2 marks]

(iii) The optimum Huffman code in order to obtain the variable length code. Show the binary code for each symbol A, B, C, D

[7 marks]

(iv) Average number of bits per codeword, $\bar{L}$

[2 marks]

(d) The generator matrix of a (7,4) Hamming code is defined as

$$\mathbf{G} = \begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 & 1 & 1 \end{bmatrix}$$

Determine the code vector produced for the message 0101.

[4 marks]

Continued .....

Appendix I: Table of Bessel Function

n \ β	0.05	0.1	0.2	0.3	0.5	0.7	1.0	2.0	3.0	5.0	7.0	8.0	10.0
0	0.999	0.998	0.990	0.978	0.938	0.881	0.765	0.224	-0.260	-0178	0.300	0.172	-0.246
1	0.025	0.050	0.100	0.148	0.242	0.329	0.440	0.577	0.339	-0.328	-0.005	0.235	0.043
2		0.001	0.005	0.011	0.031	0.059	0.115	0.353	0.486	0.047	-0.301	-0.113	0.255
3				0.001	0.003	0.007	0.020	0.129	0.309	0.365	-0.168	-0.291	0.058
4						0.001	0.002	0.034	0.132	0.391	0.158	-0.105	-0.220
5								0.007	0.043	0.261	0.348	0.186	-0.234
6								0.001	0.011	0.131	0.339	0.338	-0.014
7									0.003	0.053	0.234	0.321	0.217
8										0.018	0.128	0.223	0.318
9										0.006	0.059	0.126	0.292
10										0.001	0.024	0.061	0.208
11											0.008	0.026	0.123
12											0.003	0.010	0.063
13											0.001	0.003	0.029
14												0.001	0.012
15													0.005
16													0.002
17													0.001

Appendix II: Table of Trigonometric Identities

$$\sin A\sin B = \frac{1}{2}\left[\cos(A-B) - \cos(A+B)\right]$$

$$\cos A\cos B = \frac{1}{2}\left[\cos(A+B) + \cos(A-B)\right]$$

$$\sin(A+B) = \sin A\cos B + \cos A\sin B$$

$$\cos(A+B) = \cos A\cos B - \sin A\sin B$$

$$\sin\theta = \frac{1}{2j}\left[e^{j\theta} - e^{-j\theta}\right]$$

$$\cos\theta = \frac{1}{2}\left[e^{j\theta} + e^{-j\theta}\right]$$

Continued...

Appendix III: Fourier Transform Pairs

$x(t)$	$X(f)$
$\delta(t)$	1
$\delta(t-t_o)$	$e^{-j2\pi ft_o}$
1	$\delta(f)$
$e^{j2\pi f_o t}$	$\delta(f-f_o)$
$e^{-at}u(t)$	$\frac{1}{a+j2\pi f}$, for $a>0$
$e^{at}u(-t)$	$\frac{1}{a-j2\pi f}$, for $a>0$
$e^{-a\lvert t\rvert}$	$\frac{2a}{a^2+(2\pi f)^2}$, for $a>0$
$rect\left(\frac{t}{T}\right)$	$T\text{sinc}(fT)$
$\text{sinc}(2Wt)$	$\frac{1}{2W}rect\left(\frac{f}{2W}\right)$
$\Delta\left(\frac{t}{T}\right)$	$\frac{T}{2}\text{sinc}^2\left(\frac{fT}{2}\right)$
$W\text{sinc}^2(Wt)$	$\Delta\left(\frac{f}{2W}\right)$
$e^{-\pi t^2}$	$e^{-\pi f^2}$
$\cos(2\pi f_o t)$	$\frac{1}{2}\delta(f-f_o)+\frac{1}{2}\delta(f+f_o)$
$\sin(2\pi f_o t)$	$\frac{1}{2j}[\delta(f-f_o)-\delta(f+f_o)]$

Continued...

Appendix IV: Fourier Transform Properties

Let $x(t) \Leftrightarrow X(f)$, $x_1(t) \Leftrightarrow X_1(f)$ and $x_2(t) \Leftrightarrow X_2(f)$; and a, b, t_o and f_o scalar quantities.	
Linearity	$ax_1(t)+bx_2(t) \Leftrightarrow aX_1(f)+bX_2(f)$
Scaling ($a \neq 0$)	$x(at) \Leftrightarrow \frac{1}{\lvert a \rvert} X\left(\frac{f}{a}\right)$
Time Shifting	$x(t-t_o) \Leftrightarrow X(f)e^{-j2\pi f t_o}$
Frequency Shifting	$x(t)e^{j2\pi f_o t} \Leftrightarrow X(f-f_o)$
Time Convolution	$x_1(t) * x_2(t) \Leftrightarrow X_1(f)X_2(f)$
Frequency Convolution	$x_1(t)x_2(t) \Leftrightarrow X_1(f) * X_2(f)$
Time Differentiation	$\frac{d^n}{dt^n}x(t) \Leftrightarrow (j2\pi f)^n X(f)$
Frequency Differentiation	$(-jt)^n x(t) \Leftrightarrow \frac{d^n}{df^n}X(f)$
Time Integration	$\int_{-\infty}^{t} x(\tilde{t})d\tilde{t} \Leftrightarrow \frac{X(f)}{j2\pi f}+\frac{1}{2}X(0)\delta(f)$
Frequency Integration	$x(t)u(t) \Leftrightarrow \int_{-\infty}^{f} X(\tilde{f})d\tilde{f}$

End of Paper